DATA AND PROBABILITY
Grade 4

BIG IDEA (1): Formulate questions that can be addressed with data and collect, organize and display data to answer them

CONCEPT	EXPECTATION	EXAMPLE
A Formulate questions	Collect data using observations, surveys and experiments	Problem: The principal wants to know how many students ride the bus to school on Friday. Which of the following is the best way for her to find out? A. Ask the teachers how many students are in class on Friday. B. Stand in front of the school and count the students coming in the building. C. Ask the bus drivers to count the number of students on their bus and turn it in. D. Call the students to ask them. Answer: C Problem: Which method below is the best way for Jan to find out the fourth graders' favorite Mark Twain book? A. Read all the Mark Twain books. B. Ask all fourth graders, using a survey that contains a list of Mark Twain books. C. Ask the teacher to read his favorite Mark Twain book to the class. D. Ask the librarian how many Mark Twain books are in the library. Answer: B

CONCEPT	EXPECTATION	EXAMPLE
		TEACHER NOTES: Students should base their data-collection method on the type of data required to answer the question that is the focus of their investigation. For example, if students wish to find out which pieces of playground equipment get the most use, they might develop a plan for systematically *observing* students during several recess periods. If they want to know students' opinions about political candidates or breakfast foods, they might develop a survey. If they want to know whether light or soil deprivation has a greater effect on particular plants, they might develop a scientific experiment. Next, students will need to consider sampling: During which recess periods will they watch students? Whom will they watch? Who will answer the surveys? With what kinds of plants will they experiment? Will all plants react in the same ways? Should their experiment focus on one or two types of plants? Once students have devised a process, they need to try it out on a small sample to find out if the process actually provides data that answers the question. If not, they will need to revise the process accordingly.

CONCEPT	EXPECTATION	EXAMPLE
C Represent and interpret data	Create tables or graphs to represent <u>categorical</u> and <u>numerical</u> data including <u>line plots</u>	Problem: Make a line plot for the fourth-grade math test scores shown in the table below. Fourth-Grade Math Test Scores <table><tr><td>Score</td><td>Number of Students</td></tr><tr><td>75</td><td>卌 I</td></tr><tr><td>80</td><td>IIII</td></tr><tr><td>85</td><td>I</td></tr><tr><td>90</td><td>卌</td></tr><tr><td>95</td><td>III</td></tr><tr><td>100</td><td>II</td></tr></table>

DEFINITIONS:

categorical data—data that represent individuals or objects by one or more characteristics or traits they share, such as maleness or femaleness, blue eyes or green eyes. Categorical data are often treated as counts, proportions, or percentages of people or things in them.[1]

line plot—a diagram showing frequency of data on a number line.[2]

numerical data—represent objects or individuals by numbers assigned to certain measurable properties, such as length or age.[3]

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[1] *Navigating through data analysis and probability in grades 3–5* (p. 19). (2002). Reston, VA: National Council of Teachers of Mathematics.
[2] Cavanagh, M. (2000). *Math to know* (p. 455). Wilmington, MA: Great Source Education Group, Inc.
[3] *Navigating through data analysis and probability in grades 3–5* (p. 19). (2002). Reston, VA: National Council of Teachers of Mathematics.

CONCEPT	EXPECTATION	EXAMPLE
		Answer: **Fourth-Grade Math Test Scores** (see dot plot below)

Answer:

Fourth-Grade Math Test Scores

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Number of students

X
X                           X
X         X                 X
X         X                 X         X
X         X                 X         X         X
X         X         X       X         X         X
─────────────────────────────────────────────────
75        80        85      90        95        100
                        Scores
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TEACHER NOTES:
When interpreting categorical data, students will probably focus on data items with the "most" or "least." Teachers can press students to a deeper analysis by asking them to generalize beyond specific data items. They might ask questions such as "Can most of our favorite pets be classified as mammals?" "Do the favorite CDs reflect a particular type of music?" "Are the most favored snack items sweet or salty?" Students can be persuaded to move beyond additive reasoning (e.g., "six more people like pretzels than popcorn") to multiplicative reasoning (e.g., "twice as many people like pretzels as like popcorn," or, conversely, "half as many people like popcorn as like pretzels").

CONCEPT	EXPECTATION	EXAMPLE
		Teachers should encourage students to pay attention to important characteristics of a data set: where data are concentrated or clumped, values for which there are no data, data points that appear to have unusual values, etc. For example, if students are examining data of plant growth on a line plot, they may notice that the shortest plant measures about 15 centimeters and the tallest plant about 40 centimeters; most of the data are concentrated from 20 to 23 centimeters; and the plant that grew to a height of 40 centimeters is very unusual and considered an outlier, which is far removed from the rest of the data.[4]

[4] National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics* (p. 179). Reston, VA: Author.

BIG IDEA (2): Select and use appropriate statistical methods to analyze data

CONCEPT	EXPECTATION	EXAMPLE
A Describe and analyze data	Describe important **features** of data	Problem: A fourth-grade class made a line plot to show the number of students in their class who walked to school the first two weeks (10 days). Students Who Walk to School (line plot: Number of students vs. Day of school) Use the line plot to help you answer the questions below. 1. Which day of school did the most number of students walk to school? 2. How do you know which week more students walked to school? 3. How many more students walked to school on the first day than the eighth day? 4. What is the difference between the total number of students who walked to school the first week and the total number of students who walked the second week?

Students Who Walk to School

```
Number of students
  X
  X        X
  X        X   X                    X
  X   X    X   X           X   X    X        X
  1   2    3   4   5   6   7   8   9   10
                Day of school
```

DEFINITION:
features (of the data set)— features include the range, outliers, the median, mean, and mode. It is important that students not only identify these features, but also know what they indicate about the data.[5]

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[5] National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics* (p. 179). Reston, VA: Author.

CONCEPT	EXPECTATION	EXAMPLE
		Answers: 1. Day 1 2. You can tell from looking at the line plot that there are more Xs in week one, days 1 though 5, than week 2, days 6 through 10. 3. 4 – 2 = 2, so two more students walked to school on the first day than walked to school on the eighth day. 4. Ten students walked to school the first week, and five students walked to school the second week. 10 – 5 = 5. The difference is five students. "Students should learn statistical terms such as **range** and **outlier** that help them describe the set of data. Building on their informal understanding of 'the most' and 'the middle,' students can learn about three measures of center—**mode**, **median**, and informally, the mean....Students need to learn more than simply how to identify the mode or median in a data set. They need to build an understanding of what, for example, the median tells them about the data, and they need to see this value in the context of other characteristics."[6]

DEFINITIONS:

median (feature of data)—when the numbers are arranged from least to greatest, the middle number of a set of numbers, or the mean of two middle numbers when the set has two middle numbers.[7]

mode (feature of data)—the number that appears most frequently in a set of numbers. There may be one, more than one, or no mode.[8]

outlier—a number in a set that is much larger or much smaller than most of the other numbers in the set.[9]

range—the difference between the greatest and least value in a set of data.[10]

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[6] National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics* (p. 179). Reston, VA: Author.
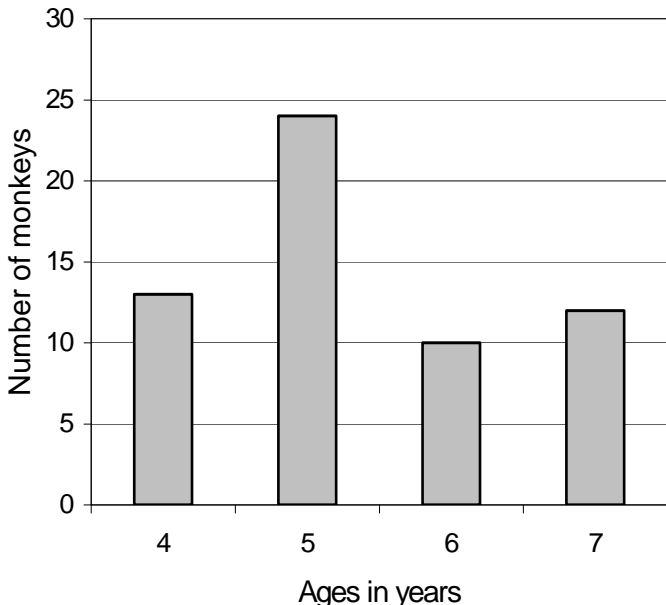
[7] *Math at hand: A mathematics handbook* (p. 527). (1999). Wilmington, MA: Great Source Education Group, Inc.

[8] *Math at hand: A mathematics handbook* (p. 528). (1999). Wilmington, MA: Great Source Education Group, Inc.

[9] *Math at hand: A mathematics handbook* (p. 529). (1999). Wilmington, MA: Great Source Education Group, Inc.

[10] *Math at hand: A mathematics handbook* (p. 532). (1999). Wilmington, MA: Great Source Education Group, Inc.

BIG IDEA (3): Develop and evaluate inferences and predictions that are based on data

CONCEPT	EXPECTATION	EXAMPLE
A Develop and evaluate inferences	Given a set of data, propose and justify conclusions that are based on the data	Problem: **Ages of Monkeys in the Zoo** _(bar graph: number of monkeys vs. ages in years — age 4: 13, age 5: 24, age 6: 10, age 7: 12)_ Based on the data in the bar graph, which of the following statements is true? Explain why. A. Most are older than six. B. Most are male monkeys. C. Most are younger than six. D. Most are seven years old.

CONCEPT	EXPECTATION	EXAMPLE
		Answer: C—The five-year-olds are the largest group, and if you add the four-year-olds to them, you get more than the six- and seven-year-olds; or, if you add the four-year-olds (about 13) to the five-year-olds (about 25), you get 38, which is more than the six-year-olds (about 10) and the seven-year-olds (about 12) added together, which is 22. Problem. The table below shows the results of a vote for a class's favorite kind of movie.

Class's Favorite Kind of Movie

Score		Number of Students
Action	Boys	👍 👍 👍
	Girls	👍 👍
Thriller	Boys	👍 👍
	Girls	👍 👍 👍
Comedy	Boys	👍 👍 👍 👍
	Girls	👍 👍 👍 👍 👍
Other	Boys	👍 👍 👍 👍
	Girls	👍

👍 = 1 student

CONCEPT	EXPECTATION	EXAMPLE
		Based on the table, which of the following kinds of movies did most students in the class prefer? Explain why you chose that answer. A. Action B. Thriller C. Comedy D. Other Answer: C—I know this because nine students chose comedy, and fewer students chose the other kinds of movies. TEACHER NOTES: "Data can be used for developing arguments that are based on evidence and for continued problem solving. As students discuss data gathered to address a particular question, they should distinguish between what the data show and what might account for the results."[11] Students should have experiences of using data sets that are samples of larger populations, such as different classrooms in their schools, comparison of their class with the median family size, etc. They should think about issues that affect how well the sample reflects the population from which it is drawn and begin to notice how samples from the same population can vary.[12]

[11] National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics* (pp.180-181). Reston, VA: Author.
[12] National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics* (pp.180-181). Reston, VA: Author.